FINAL REPORT
ERMN VITAL SIGNS PRIORITIZATION WORKSHOP
TERRESTRIAL ECOSYSTEMS WORKING GROUP

By

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PRELIMINARY WORK

Prioritization Criteria

The primary activities conducted prior to the May 19- 20 workshop were to reduce the long list of 61 vital signs to a subset that were relevant to terrestrial ecosystems and to select from this list the "high priority" vital signs.

This two-step process involved: first deciding which of the original vital signs were relevant to terrestrial ecosystems, and secondly determining which of these would be considered high priority. For the first step, the decision was clear cut for many of the vital signs. For example, vital signs relating to water quality such as Vital Signs 13, 16 and 17 (Table 1). But some, such as those related to air and climate (VS 2 and 4) affect both aquatic and terrestrial systems; therefore they are relevant to more than one working group. In the final analysis, for the Terrestrial Working Group, I considered as relevant all the vital signs from the following Level1 Groups (Table 1): Air and Climate, Geology and Soils and Ecosystem Pattern and Process. In addition, all except VS 23, 28, 29 and 39- 47 in the Biological Integrity group were considered. In the Level 1 group, Human Use, Vital Signs 51 and 54- 56 were considered relevant to terrestrial ecosystems. In total, 44 of the 61 vital signs were selected for consideration for the high priority short list. In the next step, this list of 44 was further reduced to the high priority list. Criteria used to make this selection were as follows:

- There I a strong defensible linkage between the vital sign and the ecological function or critical resource it is intended to represent.
- The vital sign represents a resource or function of high ecological importance.
- The vital sign provides early warning of undesirable changes to important resources.
- The vital sign is sufficiently sensitive to detect the specified changes (high signal-to-noise ratio) and does not exhibit large, naturally occurring variability.

Developing the Short List

To facilitate the selection process, I classified the vital signs in the terrestrial long list as "stressors" or "indicators". Furthermore, the vital signs were classified as to the resources, processes or states they affected or indicated. For example, resources included light, water, mineral nutrients, etc.; processes included succession, nutrient cycling, regeneration, etc; and states include health, vigor, fecundity and diversity. Finally, the vital signs, especially stressors, were classified as controllable or uncontrollable. In developing the short list of high priority vital signs, both stressor and indicator vital signs were included and an attempt was made to include those that affected or indicated a variety of resources and states. Particular weight was given to the stressors that were controllable and for the indicators, weight was given to those that were measurable, sensitive and had a high signal-to-noise ratio. From the long list of 44, 16 were selected for inclusion in the high priority short list. These are shown in Table 1 in bold face and are identified in column 4 as "terrestrial". Eight of the vital signs in the high priority list were considered stressors (VS1, 2, 4, 11, 18, 38, 54 and 58) and eight were considered indicators (VS5, 20, 25, 32, 34, 48, 59 and 61). In some situations VS58 (Landscape Pattern), the vital sign could be considered a stressor, depending on whether or not the changes in landscape pattern were anthropogenic and resulted in an undesirable ecosystem state. Alternatively, long-term changes in landscape pattern could be an indicator of stresses such as global climate change or over population of white-tailed deer.

Developing the Narratives

For the high priority list of 16 vital signs, narratives were prepared using the following outline:

- Title
- Brief description
- Significance/Justification
- Proposed metrics
- Prospective Method(s) and Frequency of Measurement
- Limitations of Data and Monitoring
- Key References

The literature was reviewed and annotated by R. Stockton Maxwell, WVU Division of Forestry Graduate Student, and the narratives were drafted by myself and reviewed by Dr. James Rentch, Visiting Assistant Professor at WVU in the Division of Forestry. After preparing drafts for three vital signs, they were sent to Matt Marshall, Ecologist for the Eastern Rivers and Mountains Network for his review. Based on his comments, these narratives were revised and used as a template for completing the remaining 13 narratives. During this process, a meeting was held in State College, PA for the Core Planning Team. At this meeting, Matt Marshall discussed with us his concept of how the narratives should be structured, and we discussed the agenda for the up-coming prioritization workshop.

The narratives for the terrestrial vital signs were completed prior to April 15, 2005 and reviewed by ERMS personnel. The revised narratives were forwarded to the participants in the Terrestrial Ecosystems Working Group (Table 2). These individuals represented specialties ranging from biology, climatology, ecology, entomology, geography, herpetology, landscape architecture, mammalogy, soil science and wildlife biology. There were a total of 20 participants in the Terrestrial Ecosystems Working Group.

THE WORKSHOP

Setting the Stage

The prioritization workshop took place over a two-day period in State College, PA. The goals for the working groups were to finalize the short lists of vital signs and to prioritize them into tier 1, 2 and 3 priorities. The workshop began with a brief presentation to the combined working groups by Mat Marshall in which he provided a historic background for the National Park Service’s ecological Monitoring Program. In addition, he briefly outlined the expected outcomes of the workshop as well the recommended process for achieving these outcomes. Following this presentation the three working groups (Terrestrial, Large Rivers and Tributary

Streams) separated into break-out sessions. My role was to facilitate the functions of the Terrestrial Ecosystems Working Group (see Table 2), aided by Dr. James Rentch and Stockton Maxwell. The first order of business was to introduce the facilitation team, to describe the preliminary work that had been done and to present to the group a brief overview of the process we would utilize to accomplish the goals of the workshop. After completing this presentation, all members of the working group were invited to introduce themselves, to describe their background and to indicate how they expected to contribute to the final product (the ranked priority list of vital signs).

Finalizing the Short List

The preliminary sessions of the workshop were completed by mid morning of the first day, after which we turned our attention to finalizing the short list of high-priority vital signs. Although the narratives for the 16 proposed high-priority vital signs had been previously distributed to the participants, we briefly reviewed the list again. The process was accomplished in two phases. First, we went through the proposed vital signs, one at a time, and decided if any of them should be deleted from the proposed list. Secondly, we determined if any of the original 61 vital signs had been omitted that should be incorporated in the final short list.

The first phase was accomplished by reviewing the vital signs on the proposed short list, one at a time, beginning with a brief justification as to why they had been selected for inclusion and proceeding to a discussion of the vital sign among the participants. This generated lively discussions on many of the vital signs. At the conclusion of discussions for each vital sign, the group was polled as to whether or not the vital sign should be retained on the short list. As a result of this process, three vital signs were dropped from the short list. These were Phenology (VS5); Lichens, Liverworts, Mosses and Bryophytes (VS23); and White-tailed Deer (VS38). Two of these were indicator vital signs (VS5 and 23) and VS 38 was classed as a stressor. A substantial amount of discussion led to the deletion of these three vital signs and although it is not possible to capture it all in a few brief paragraphs, I will attempt to report the gist of the discussions. For VS5 the discussion concluded that phenology may be a valuable indicator for long-term global climate change, but to be useful in the context of ecological monitoring of ERMN parks, data would have to be collected for many decades (perhaps centuries) in order to detect trends. In the short term, normal year-to-year weather fluctuations would mask trends, so a relatively low signal-to-noise ratio exists for phenological data as a predictor of ecosystem trends. Regarding VS 23, it was acknowledged that some of these plants are sensitive to changes in air and climate phenomena such as acid deposition, ozone and global climate change. But here again, the signal-to-noise ratio, the signal-to-noise ratio is relatively low and these organisms may be influenced by a number of other naturally-occurring factors such as overstory canopy changes that occur due to successional trends or natural disturbances (wind, fire, ice, treefall gaps, etc.). For white-tailed deer (VS38), the group acknowledged that deer browsing exerts a profound effect on ecological processes such as forest regeneration and may be partly or totally responsible for long-term species changes within the ERMN region. But wildlife biologists and mammalogists in the group pointed out that it is difficult, perhaps impossible to obtain affordable and reliable census data on deer populations. Furthermore, the ERMN parks are surrounded on all sides by non-jurisdictional lands, thus regulating deer populations on NPS lands alone may not have much effect on the functional impact of deer in the parks.

The next step in the process was to revisit the vital signs in the original long list of 61 to determine if any should be added to the short list. Table 3 shows the short list of 17 that resulted after deletion of three and addition of 4 new vital signs. As can be seen in Table 3, all the added vital signs were multiples of two or three of the original 61. In two cases, the new vital sign involved broadening a vital sign by incorporating a new one with an existing one. This was true for VS20/28 where Riparian Plant Communities (VS28) was added to Forest Plant Communities-Structure and Demography (VS20). The group's opinion was that riparian zones often blend into upland plant communities in the ERMN region in a manner that makes the separation of the two communities artificial and needless, especially at the tributary/terrestrial interface. Likewise, the group felt that VS57 (Land Cover-Land Use Change) should be combined with VS58 Landscape Pattern). The consensus of the group was that human activities such as development, roading, agriculture, etc. are a dominant factor in the changing landscape pattern of ERMN landscapes. Indeed, the National Park lands are part of a larger landscape, much of which is profoundly affected by human activities. Many times the effects of these activities spill over into the parks. Examples of this are introduction of exotic invasive species, anthropogenic fires, air and water pollution.

Two new vital signs were added to the short list that contained combinations of the original 61, none of which were on the previous short list. These were VS49/50 (At-Risk Species and Communities) and VS30/33/35 (Terrestrial Mammals). The rationale for including the at-risk species and communities was principally based on the fact that many unique T&E species and communities, in addition to their rarity, are highly sensitive and vulnerable to ecosystem perturbations, thus they may provide an early warning mechanism for identifying ecosystem changes that may threaten other communities if the change progresses. In addition, the group saw no reason for separating state and federally listed species, a distinction that appeared to be more political than ecological. Finally, the last new vital sign added was a combination of VS 30, 33 and 35. These were all related to mammalian populations (riparian mammals, bats and Allegheny woodrat). The reasons expressed for combining them were similar to those given for choosing the at-risk species and communities, namely, they are relatively sensitive species that could serve as early warning signals for potentially damaging ecosystem changes. Furthermore, it was pointed out that plants, arthropods and herps were already well represented on the current short list whereas mammals were not.

<u>Prioritizing The Vital Signs</u>

The process of producing a final short list consisting of 17 vital signs was completed at the end of the first day of the workshop. The second day's activity was to focus on creating a three-tier ranking for the vital signs on the short list. Workshop participants were reminded by the organizers as to the criteria that should be used for the prioritization process (as stated in the initial section of this report). Following that a brief discussion of the 17 remaining vital signs took place in order to remind participants what they represented and to give a final opportunity for people to express their opinions and thoughts. Following this, the group discussed what mechanism we would use in order to develop the priority ranking. It was decided that the participants would, by ballot, vote on each vital sign as to whether they believed it to be tier 1, 2 or 3. No set number of vital signs was stipulated in each tier, but participants were instructed to make an effort to rank some vital signs in each category. The process used to evaluate the combined ranking was to sum all the scores of the participants for each vital sign (tier 1= 1, tier 2= 2, tier 3= 3). The final tier ranking was based on these summary rankings, with the breaks between tiers being defined by obvious breaks in the summary rankings. We also looked at the frequency that a specific vital sign was ranked in a specific tier as an aid to establishing the final ranking. The first time we applied the above procedure, the list of tier 1 vital signs consisted of five, but none of them were related to weather and climate, an area that many of us felt was important, and should have been ranked higher. After discussions among the workshop participants and consultation with Matt Marshall, it was decided to conduct a re-vote. The second vote took place after the general session where all three working groups had an opportunity to present and discuss their rankings. Based on the re-vote, five vital signs were assigned tier 1 status (Table 4). These were VS20/28, (Plant Communities- Structure and Demography/Riparian Plant Communities); VS57/58 (Land Cover/Land Use Change/Landscape Pattern); VS18 (Invasive Plants, Animals and Diseases- Status and Trends); VS2 (Air Chemistry- Wet and Dry Deposition, Contaminants); VS32 (Breeding Bird Communities). Among these, three were considered "indicators" (VS20/28, VS57/58 and VS32) and two were considered "stressors" (VS18 and VS2). They represent a variety of level categories including Air and Climate, Biological Integrity and Ecosystem Pattern and Process.

POST-WORKSHOP ACTIVITIES

Since completing the workshop Stockton Maxwell has refined the transcript of the proceedings of the Terrestrial Working Group sessions at the workshop and has developed tabulations of the final votes and rankings of the vital signs in our final short list. Jim Rentch and Matt Marshall are in contact regarding the development of a Terrestrial Ecosystems Conceptual Model and is starting to work on producing a visual model. Previously-developed narratives of the vital signs on the short list have been routed to reviewers who have specific knowledge and background for their comments and I have been assigned the task of developing new narratives for new vital signs that were added at the workshop (generally combinations of previously-included vital signs or new ones added to the short list). In the case of a couple of vital signs that were added to the short list during the workshop, no narrative was done. In these cases, reviewers were askes to develop a narrative. The final edited and approved narratives are included in Appendix X (to be added).

Finally, this report was produced with extensive help from Stockton Maxwell, Jim Rentch and Matt Marshall. It is intended to document the purpose, process and results of a vital signs assessment workshop for the ERMN parks and it provides the park managers with a prioritized list of vital signs that should serve as the basis for an ecological monitoring program.

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Table 2. Workshop participants of the Terrestrial Ecosystems Working Group.

Vital Sign #	Vital Sign Name
20 & 28	*New: Plant Communities - Structure and Dynamics (forest and riparian)*
57 & 58	*New: Landscape Dynamics (LU/LC Change and Landscape Pattern)*
6	Invasive Species - Status and Trends
2	Air Chemistry - Wet and Dry Deposition
32	Breeding Bird Communities
12	Soil biota, organic matter, and chemistry
4	Weather and Climate
48	Reptiles and Amphibians
1	Ozone
49 & 50	*New: At-risk Species and Communities (Fed, State, and special concern)*
34	Terrestrial Invertebrates
19	Invasive Species - Early detection
61	Nutrient Dynamics
11	Soil Erosion and Compaction
30, 33, & 35	*New: Terrestrial Mammals (bats, woodrats, riparian mammals)*
54	Visitor Usage and Impacts
59	Primary Productivity
REMOVED	
38	White-tailed Deer
25	Lichens, mosses, bryophytes, etc.
5	Phenology

Table 3. Final short list of Vital Signs considered for ranking by the Terrestrial Ecosystems Working Group (including the three that were deleted).

	VS #	Vital Sign Name	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	Sum	Count 1	Count 2	Count 3
TIER 1	7	Plant Communities	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17	**17**	0	0
	15	Landscape Dynamics	1	1	2	1	1	2	1	1	3	1	1	1	1	2	1	1	1	22	**13**	3	1
	6	Invasive Species - Status and Trends	3	1	1	2	2	1	2	1	1	1	1	1	1	1	1	1	2	23	**12**	4	1
	2	Air Chemistry - Wet & Dry Deposition	1	3	1	1	1	1	1	2	1	1	2	2	2	3	2	1	1	26	**10**	5	2
	9	Breeding Bird Communities	2	1	2	1	2	2	1	1	1	2	2	1	1	1	1	1	2	24	**10**	7	0
TIER 2	8	Soil biota, organic matter, and chemistry	2	2	1	2	1	1	2	2	3	2	1	3	2	2	1	2	2	31	5	**10**	2
	3	Weather and Climate	1	3	1	1	1	3	3	3	2	2	3	1	1	3	2	1	2	33	7	**4**	6
	13	Reptiles & Amphibians	2	1	2	2	1	2	2	2	2	2	1	3	2	2	1	3	1	31	5	**10**	2
	1	Ozone	2	3	3	2	3	1	1	.	2	2	3	1	2	3	2	2	2	34	3	**8**	5
	10	At-risk Species and Communities	3	1	2	2	2	3	1	3	3	2	1	1	2	1	2	1	2	32	6	**7**	4
	11	Terrestrial invertebrates	2	2	3	1	1	1	2	2	3	3	2	3	1	1	1	3	2	33	6	**6**	5
	4	Invasive Species - Early Detection	2	3	3	1	2	3	3	2	1	3	2	3	3	2	3	1	1	38	4	**5**	8
	17	Nutrient Dynamics	2	3	2	2	2	2	1	3	3	3	2	3	2	3	2	2	1	38	2	**9**	6
TIER 3	5	Soil Erosion and Compaction	3	2	3	3	3	3	2	2	3	3	3	2	2	1	2	2	2	41	1	8	**8**
	12	Terrestrial Mammals	3	2	3	2	3	2	2	3	2	3	3	3	3	3	3	1	3	44	1	5	**11**
	14	Visitor Usage and Impacts	3	2	3	3	3	3	3	3	1	3	3	2	3	2	3	3	1	44	2	3	**12**
	16	Primary Productivity	3	3	3	3	3	2	3	3	1	3	3	3	2	3	3	2	3	46	1	3	**13**

Table 4. Final priority ranking (Tier 1, Tier 2, Tier 3) for the 17 Vital Signs in the final short list for the Terrestrial Ecosystems Working Group